Growing Beyond Earth PlantLab Guide for School IT

Applies to firmware 1.0 (September 2026) and later. Last updated 2026-09-10.

Devices shipped before 2026 run the original MicroPython firmware and are not as described in this document until updated. The update is a one-time installation over USB, covered by the installation guide distributed alongside this document; once applied, the device behaves as described here and receives all subsequent updates automatically.

About Growing Beyond Earth

Growing Beyond Earth (GBE) is a classroom science program created by Fairchild Tropical Botanic Garden in partnership with NASA. Students grow edible plants in a standardized growth chamber — the **PlantLab** — and their experiments contribute to research on growing food in space. The program is active in more than 500 schools.

The device

The PlantLab is a benchtop growth chamber controlled by a Raspberry Pi Pico W microcontroller. It is **not a general-purpose computer**: there is no operating system, no shell, and no remote login of any kind. The device runs a single signed firmware image and nothing else.

The device:

- Controls an RGBW LED light panel, a circulation fan, and a general-purpose 12 V auxiliary output, following a schedule the class writes as a simple JSON file (the “program”).
- Measures temperature, humidity, CO2, light, soil moisture, and its own electrical power draw. It has **no camera and no microphone**.
- Logs readings to its SD card every 10 minutes and, when connected to WiFi, reports the same readings to the GBE server, where the class can view current conditions and history online.

Scanning the **QR code on the PlantLab's LED panel** opens that device's page, which shows its hardware details — MAC address, firmware version, device ID, and device name — along with the latest version of this and the other PlantLab documents. This is the quickest way to collect a unit's MAC address for network registration.

How a classroom gets set up

The typical flow is entirely through the **GBE Connect** phone app, over Bluetooth LE, standing next to the device:

1. The teacher plugs in the PlantLab and opens GBE Connect nearby.

2. The app finds the device over Bluetooth and connects.

3. In the app, the teacher names the device and enters the school WiFi credentials.

4. From then on the device runs on its own; the app is used for program changes, updates, and occasional check-ins.

An SD-card path exists for every configuration task (a settings file placed on the card), but in practice most teachers use only the app. No step requires a school-managed computer, browser configuration, or inbound network access.

WiFi connectivity is recommended. A connected PlantLab can be checked remotely in real time — by the class, from home, or by GBE support during troubleshooting — and its data reaches the online charts continuously with no action from the teacher. The device can operate without WiFi, but with a reduced experience; see “Operation without WiFi” below.

Network behavior

- WiFi client only: WPA2-Personal (a network name and password), 2.4 GHz. The device never creates an access point and never listens for inbound connections — there are no open ports to scan and no web interface on the device.

- **The PlantLab does not support enterprise WiFi.** Networks requiring 802.1X/RADIUS authentication (WPA2-Enterprise), per-user logins, captive portals, or web-based sign-in pages will not work. This is the most common WiFi obstacle teachers encounter; the solution is a guest or IoT network with an ordinary pre-shared password.

- All traffic is outbound:

Destination	Protocol	Purpose
`growingbeyond.earth`	TCP 443 (HTTPS)	Telemetry (~every 10 min), program sync, firmware update checks
NTP	UDP 123	Clock synchronization
Public web APIs (optional)	TCP 443 (HTTPS)	Only if a classroom program explicitly fetches one (e.g. a

- HTTPS certificate verification is enforced against pinned Let's Encrypt roots (ISRG Root X1 and X2); a failed certificate check fails the connection.

- Programs that fetch public APIs are egress-filtered on the device: requests to private and internal address ranges are refused, so a classroom program cannot be used to probe the school network.

- WiFi is optional but recommended (see “Operation without WiFi”). Both radios can be disabled outright (see “Controls available to IT”).

Recommended placement: a guest network or IoT VLAN with an ordinary pre-shared password, per normal IoT practice, with outbound TCP 443 to `growingbeyond.earth` and UDP 123 allowed.

Bluetooth

Bluetooth LE is the local-setup and check-in channel for the GBE Connect phone app. Relevant design points:

- BLE range is room-scale. The access model is that **physical proximity is authorization** — the same model as the SD card slot. There is no PIN or pairing step; the device has no display on which to conduct one.

- The one secret that crosses BLE — the WiFi password — does not rely on Bluetooth link security. It is encrypted at the application layer (ECDH key agreement with AES-GCM) between the app and the device, so it is protected regardless of the link.

- What BLE exposes otherwise: live sensor readings, device status, program management, and firmware update delivery — the same class of actions available to a person standing at the device. The device stores no student data for any channel to leak.

Operation without WiFi

The device operates correctly without WiFi, but the experience is reduced: there is no remote real-time view of the device, and data reaches the online charts only when a teacher uses a phone app to sync.

- The device keeps its full log on the SD card regardless of connectivity, and continues running its program.

- Readings destined for the online charts are cached on the card. If WiFi is restored, the backlog uploads automatically.

- When a teacher connects with GBE Connect, the app relays the cached backlog (and can deliver firmware updates) through the phone's own internet connection. GBE advises teachers of offline units to connect at least a few times per week. For network accounting purposes, note that data relayed this way reaches `growingbeyond.earth` via the teacher's phone rather than the school network.

What data leaves the school

Telemetry entries contain: device identity (device name, hardware address, firmware version), sensor readings, light/fan/aux output states, and device health counters (uptime, memory). No student names or accounts exist on the device, no personal data is collected, and there is no camera or microphone. WiFi passwords are never transmitted to GBE — see below.

Credential handling

- WiFi credentials are stored on internal flash, obfuscated with a device-derived key (the RP2040 has no secure element, so this is obfuscation rather than hardware-backed encryption — as on most microcontroller-class devices).

- They are never written to the SD card and never appear in any log. If credentials are supplied via an SD settings file, the file is blanked (zero-overwritten, then deleted) immediately after reading.

- Units upgraded from the original MicroPython firmware read that system's plaintext `wifi_settings.json` from the card once, then scrub and delete it.

- When troubleshooting a device, the GBE team may ask a teacher to send `logs/startup/output.txt` from the SD card (boot output, overwritten each boot). It contains the firmware version, hardware status, network name, and signal strength/scan results — never the WiFi password.

Firmware updates

- Every firmware image is signed (ECDSA P-256) by the GBE team; signing keys are held offline, never on the update server. The device's bootloader verifies the signature before an update can run; unsigned or tampered images are rejected and the device automatically rolls back to its previous firmware.

- Downgrades below a minimum version are refused (rollback protection).

- Delivery: over HTTPS from `growingbeyond.earth` when the device has WiFi, or through GBE Connect over Bluetooth when it doesn't. A USB installer exists for first-time upgrades and recovery.

- Net effect: firmware cannot be installed by any party other than the GBE team, regardless of network position.

Controls available to IT

- **Network placement** — the device requires nothing from the school LAN; guest/IoT segregation involves no loss of functionality. This is the recommended way to accommodate the device: it preserves the full experience, including remote monitoring.

- **Offline operation** — if WiFi cannot be provided, the device still runs its program, logs to the SD card, and remains manageable over Bluetooth, with the limitations described under “Operation without WiFi”.

- **Radio lockdown** — setting `WIFI_ENABLED` and `BLUETOOTH_ENABLED` to `false` in `wifi_bluetooth_enabled.json` on the SD card silences both radios entirely. Lockdown can only be set or lifted physically at the device — there is no remote or Bluetooth path to change these flags. (Re-enabling Bluetooth takes effect at the next power-up.)

Questions

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